

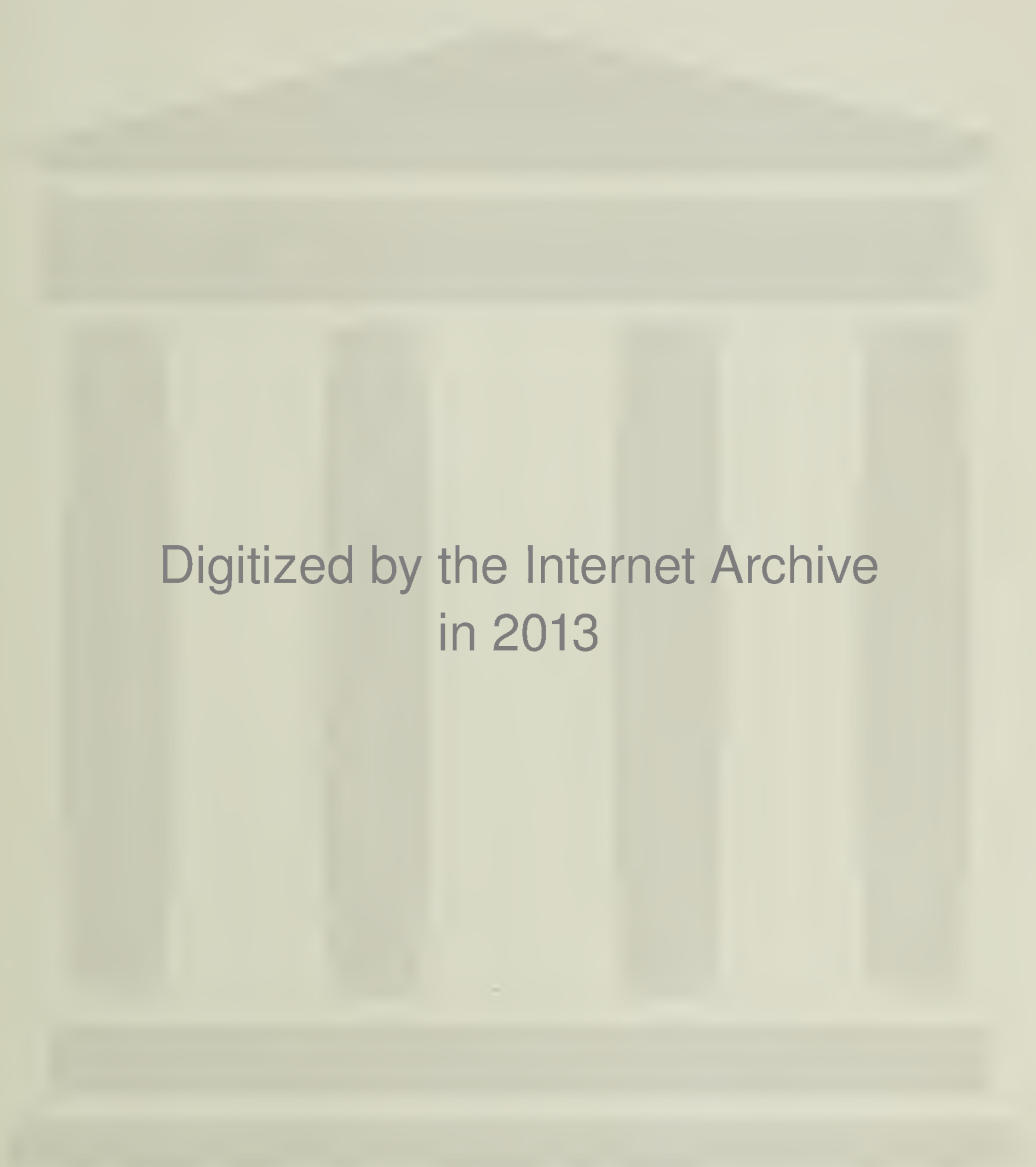
UNIVERSITY OF ILLINOIS-URBANA

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QUARTERLY TECHNICAL PROGRESS REPORT
of the
INFORMATION ENGINEERING LABORATORY
for the period
November 1977-January 1978

February 1978



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DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN · URBANA, ILLINOIS

Quarterly Technical Progress Report
of the
Information Engineering Laboratory
for the period
November 1977-January 1978

February 1978

Department of Computer Science
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

1. Introduction

This report is intended to keep interested persons informed about the progress on various research projects being carried out by the Information Engineering Laboratory of the Department of Computer Science. Each report lists those projects which have been completed, summarizes progress on those which are currently active, and provides introductory remarks on new projects. For each project, the source of funding is identified in brackets: [].

The research is carried out by half-time graduate research assistants (graduate students) under the direction of one or more faculty members. The final documentation on a given project is usually in the form of the students thesis (MS or Ph.D.). These theses are often published as technical reports and are listed, along with an abstract in the "projects completed" section of this report. In some cases technical reports are issued which are not theses and these are also listed. It is also possible that a thesis is produced which is not issued as a technical report.

Some of the research is the result of a research proposal and in such cases a more detailed account of the proposed research can be found by consulting the relevant proposal. In other cases the research is a result of ideas originating with a student or staff member. In either case, an introductory description of the proposed research appears when a new project is introduced into the report. Thereafter only a brief synopsis is included.

Section two summarizes the projects completed during the quarter, section three presents progress reports on current projects, and section four introduces new projects. Projects are listed by name and a corresponding project number is given in parentheses.

2. Summary of Projects Completed During the Quarter

The projects completed this quarter are listed below by project name and number along with the technical report number and the abstract. Some reports are available directly from the Department of Computer Science, University of Illinois, Urbana, IL 61801. Others may be obtained from the Engineering Documents Center, 208 Engineering Hall, University of Illinois, Urbana, IL 61801 or from the IEEE Computer Society Repository, 5855 Naples Plaza, Suite 301, Long Beach, CA 90803.

OTEMON (Project #95) [DCS]

A continuous waveform visual monitor was designed in the form of a small, cheap TV controller. It is primarily intended for the display of natural phenomena such as EKG signals, although other application can be envisioned. The controller divides the TV screen into a number of "bands" along which the signal is displayed. The number of bands is variable, and the resolution changes accordingly.

The final documentation is an M.S. Thesis. No technical report will be issued.

3. Progress Report on Continuing Projects

Source of funding is given in brackets: [Source]

Parallel Hardware Algorithms for High-Speed Function Generation (#73)

[DCS]

INTRODUCTION

This project considers the problem of high speed parallel hardware function generation. The function $f(x)$ is to be evaluated in the interval $[a,b]$. The interval $[a,b]$ is broken down into a few subintervals $[x_k, x_{k+1}]$ within which f is piecewise approximated by a polynomial. Each interval uses a different degree polynomial. x_k is called a joint. The coefficients of these polynomials are stored in ROMs. The argument x is logarithmically distributed since it is assumed to be a floating point mantissa in the interval $[.5,1]$. The goal is to minimize the average number of multiplications $M(X)$ needed to evaluate $f(x)$ subject to a constraint on the number of ROM words $R_0(X)$ where X is the vector of subinterval breakpoints (x_0, x_1, \dots, x_m) .

PROJECT STATUS

During this quarter the final report was written and it should appear during the next quarter.

Gilles Garcia

PREDICTORBURST (#81) [DCS]

INTRODUCTION

The goal of this project is the real-time extraction of predictor coefficients from a human voice signal. These coefficients, used in the linear prediction of speech, are employed so as to encrypt the message or transmit it over narrow band digital data lines.

PROJECT STATUS

During this quarter, a software simulation program (in PL/I) was developed for the circuit. Gate-level simulation reflecting the actual signal flow was employed. A variety of input signals was used and the clock rate was varied to allow examination of the dynamic behavior of the coefficients and the error signal. Initial results of the simulation were the discovery that the fast clock (32 times the frequency of the sample bit rate clock) used for updating the coefficients was not only unnecessary but also detrimental to the stability of the coefficients, and the realization that an increase in estimate accuracy is obtained when the sample-and-hold is removed from the input stage. Further simulation is continuing both to finalize the topology and to observe the circuit's behavior when presented with different input waveforms.

Daniel Pitt

INDIRAD (#82) [DCS]

INTRODUCTION

INDIRAD is a digital A.M. receiver which uses indicator representation of data for high speed processing.

PROJECT STATUS

A major portion of the last quarter was spent awaiting receipt of parts. Construction has begun on the ECL logic board, and about 25% of it is now complete.

Two related sections of the radio were redesigned. The 4x4 multiplexer was eliminated by right shifting the data in the counters the appropriate number of bits using the load input of the counter (refer to Fig. 1 of November, 1977 report). To control this loading the clock generator and counter control were also redesigned. The new design permits the passband width of the filter to be more finely adjusted, and should improve the rejection of unwanted signals.

Gary Gostin

PEARL (#83) [UIUC Research Board]

INTRODUCTION

PEARL (Portable Evoked Average Response Laboratory) is a portable, intelligent device for monitoring psychophysiological experiments and collecting data.

PROJECT STATUS

This project is complete but, as yet, no final report has been issued.

Tony Mui

ILLIBOT (#86) [DCS]

INTRODUCTION

The goal of this project is to construct a robot capable of surviving totally on its own in a potentially hostile environment. The robot will require no human guidance or interference.

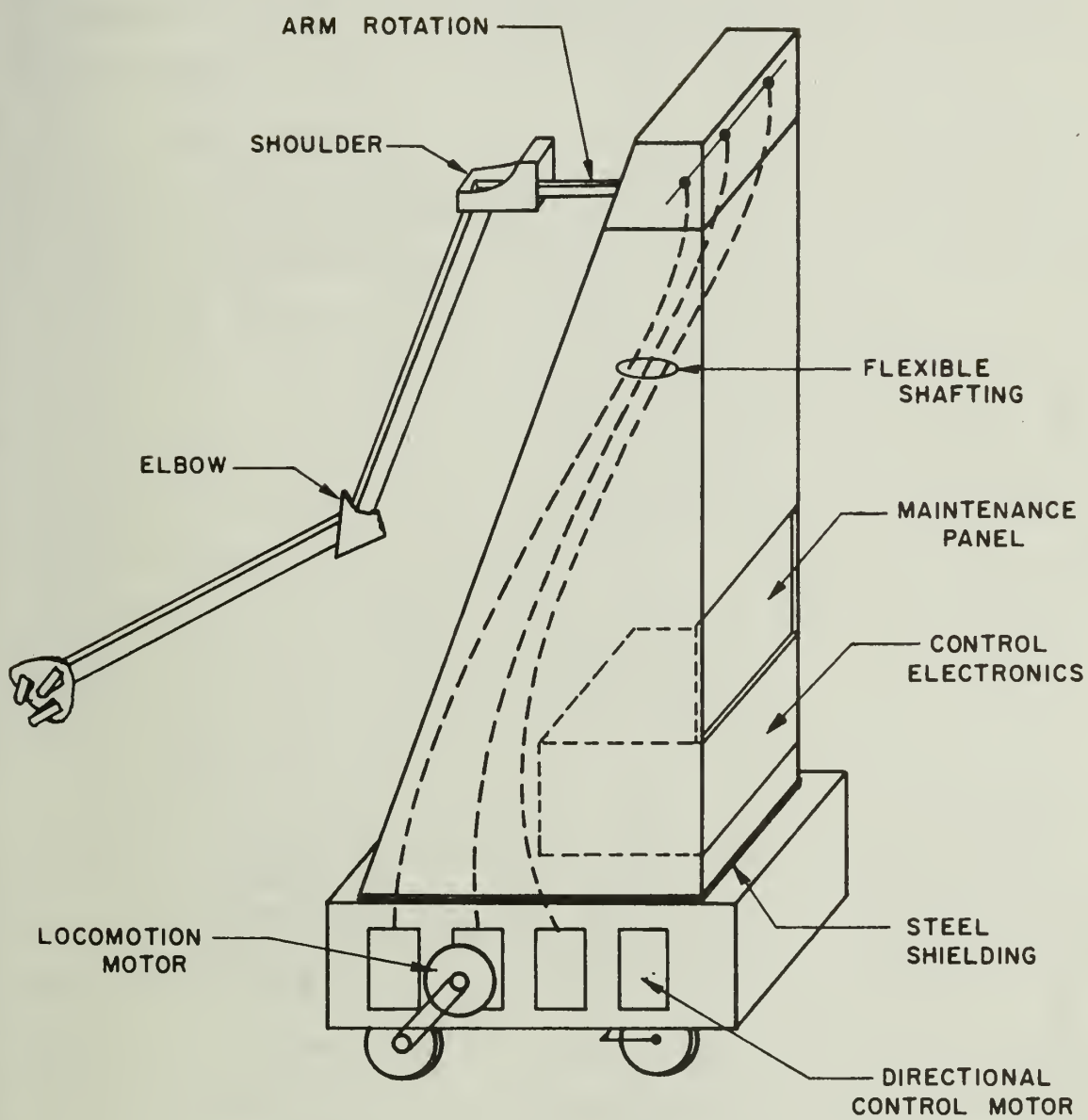
PROJECT STATUS

During the past quarter several approaches to the realization of ILLIBOT have been considered. It is currently impractical to consider constructing ILLIBOT in its present form. Instead, as previously stated, we have decided to test small sections of ILLIBOT separately on board a smaller robotic system presently designated ALPHA II. (See Figure 3.1) ALPHA II will be connected to a DEC PDP-11/20 RT system as a peripheral TTY. (See Figure 3.2). The on-board electronics consist of a command controller, sensory center and motor controller. In addition, expansion for a vision system is provided. The motors as well as the senses are modular in that their existence is optional and their absence will in no way degrade the hardware defined operations of the robot. A maximum of 16 senses and 16 motors are allowed in the design that is presently being built. Motor timing circuits, of synchronous design utilizing 6 bit binary rate multipliers, were developed and tested shortly after ALPHA I. These are being used in ALPHA II. The general scheme of using a single main sequencer to control the robot has been rejected in favor of a main status register with subsequencer. In addition, differential feedback circuits tested and built for ALPHA I will again be used for ALPHA II.

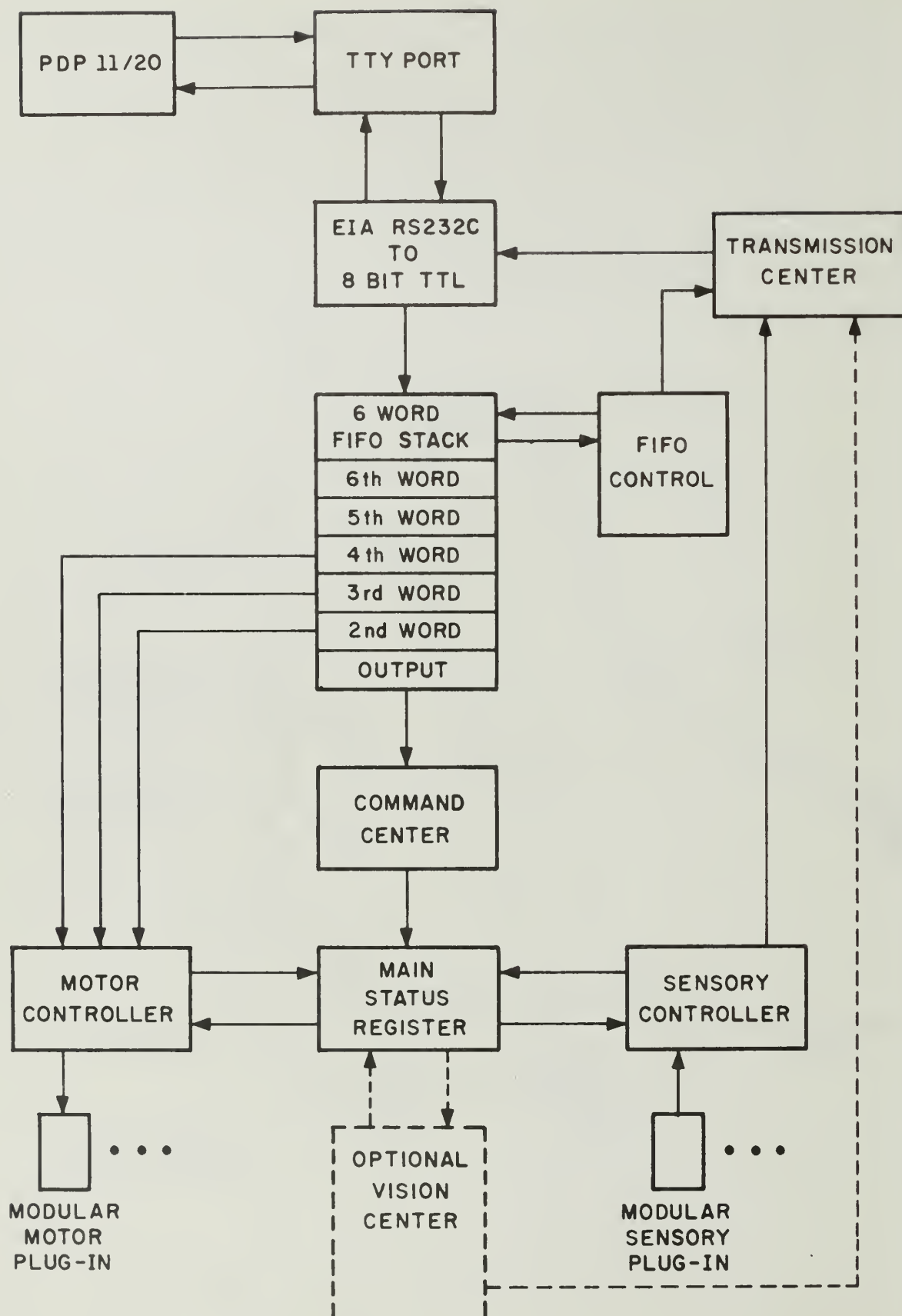
The 6 motors will be housed in a well-shielded area away from the electronics. These motors, operating on a 12 volt system, will be used for locomotion, directional control, rotation of the arm, a shoulder joint, an elbow and the opening and closing of the hand. With the exception

of the locomotion motors, all are high speed low amperage motors that are geared down to a low speed and high torque. An example of this is the directional control motor which is a 12 VDC, PM field reversible motor which yields 10 RPM at 40ma full load, with torque of 40 oz-in. Motor energy (rotational) is transmitted via flexible shafting to a plate near the arm where it is transferred to push/pull energy via bellcranks. These, in turn, pull sheathed metal cables that cause the physical mechanical movement in the arm. The hand described last quarter has been greatly simplified so that it could be hand machined. It is presently a task as the programmer is ingenious in programming the 11/20. In other words, all the decision making that would be made on ILLIBOT by hardware has been moved to software for ALPHA II. This has been done for several reasons: 1) To provide flexibility during research and testing. 2) To facilitate rapid improvement and modifications. 3) To provide a more practical approach toward the realization of ILLIBOT.

Jeff Glickman



ALPHA II Figure 3.1



SYSTEM BLOCK DIAGRAM Figure 3.2

PLANOBURST (#88) [DCS]

INTRODUCTION

PLANOBURST uses Burst unary processors to implement a class of matrix processing functions characterized by two main features: First, the operation performed on a particular element is solely a function of the elements in a small surrounding neighborhood, and second, the operation is to be repeated a number of times.

PROJECT STATUS

The scope of this project has now stabilized and will concentrate on a visual pattern recognition system intended for use by a simple robot, i.e. the class of input patterns is neither known nor bounded.

In use, the system would take a TV picture and produce from it a characteristic vector which would be compared to the characteristic vectors of previously encountered images. If no match were found, the vector would be stored as a newly encountered image. Associated with each image encountered would be a number of data bits which would guide the robots reaction to a repeated encounter with an image.

FUTURE WORK

The first area of investigation should obviously be the means by which a characteristic vector is to be derived from an image. Some methods which have been suggested are the Fourier, Hadamard, Haar, Cosine, Slant, Karhunen-Loeve and other transforms, the method of moments, auto-correlation and contour analysis. It is necessary to find a method which will give invariant results under the operations of translation, magnification and rotation. During the next quarter an investigation will be made of how each approach performs in the areas of invariance, hardware cost, speed and computational efficiency, as well as related areas such as the means of comparing stored patterns.

Michael Robinson

MICROCARDALERT (#94) [EE and School of Clinical Medicine]

INTRODUCTION

"CARDALERT" is a microprocessor-based cardiac signal analyzer. It detects the presence of premature ventricular contractions [PVC] in heart beats due to heart diseases. By detecting these abnormal contractions, cardiac arrests can be predicted.

PROJECT STATUS

The ECG-PVC detect computer program has been completed and is ready for demonstration purposes. Preliminary tests indicate that the program detects almost all of the clearly discernable PVCs. The program also detects and counts premature atrial beats (PABs). However, no statistics have been compiled as to the percent of PABs detected.

We are using the PDP8/e system presently, and have operated in two modes; 1) using various recordings which are recorded at 15 times the normal rate and 2) using real-time signals from electrodes placed on a subject. We use a sampling interval of 250 microseconds for the tapes and 2 milliseconds for the real-time data. Changing between different tapes or between tape and real-time requires approximately one half to one hour. This change involves the modification of five variables which allow the program to detect the characteristic waveforms of the different lead positions which were used when recording the various tapes.

Preliminary tests also indicate that the program is relatively insensitive to the DC shifts and to high frequency noise which arises from the normal movements of real-time subjects. However, the program is highly sensitive to atrial fibrillation (an uncommon, erratic, extremely fast heart beat) and the validity of PVC detections is destroyed if this occurs.

A version of the program which can be executed using the IM6100 is ready. This program differs from the one run using the PDP8/e in that the interrupt system of the PDP8 is replaced with a DMA and UART interface on the IM6100.

Jeff Anderson

MUMS II (#96) UNIVERSAL COMPILERS FOR MICROPROCESSORS [DCS]

INTRODUCTION

This project was undertaken to implement the language C on the MOS Technology 6502 and the Intel 8080 microprocessors as part of the MUMS system. The language C is well suited to this application because it allows efficient utilization of machine features while not requiring much in the way of translation facilities. The objective of the project is to study the process of machine-independent compilation. One by-product of the project has been the implementation of working compilers for the 8080 and 6502 processors. However, due to limited system resources, these compilers cannot be released for public use. The compilers consist of three programs. The first program is the front end processor of an existing C compiler. The second program serves as a linkage editor and can combine several IL files into one. The third program is called COMP. See the last quarterly report for a more extensive explanation.

PROJECT STATUS

To make these compilers available to the local student community a version of COMP has been written to produce interpretive code. An interpreter written in PASCAL has also been produced. This mechanism has been tested on a small desk-calculator program. Testing is in progress of large programs, including the C macro preprocessor. To support this interpreter, a new version of COMP has been implemented which generates only the interpretive code representing the compiled program. This interpretive code is suitable for interpretation by the PASCAL program. Only a minor change to the COMP was necessary. This interpretive code may be executed using the CYBER as an interactive test bed by using the C interpreter. This allows greater flexibility than we can presently achieve with the MUMS system. Users of the system are provided with a more stable environment and one can bootstrap

off of the CYBER rather than trying to use the microprocessors themselves to develop software.

Future efforts will be towards implementing the entire cross-compiler system on the CYBER.

At this point, the currently available cross-software on the CYBER is as follows:

- 1) Intel MAC-80 assembler
- 2) Intel PLM compiler
- 3) Intel INTERP-80 simulator
- 4) MOSTEK ASSEMB assembler (6502)
- 5) Z-80 assembler

The first four are commercial products and are written in FORTRAN. The Z-80 assembler (written by G. Lehman) is a PASCAL program supporting relocatable code generation and external references. A linking loader will be completed soon allowing the user to combine separate assemblies, searching a user-defined library for unsatisfied references.

George Lehman

Lawrence Lopez

4. Progress Report on New Projects Begun this Quarter

This section introduces new projects begun during this quarter.

The source of funding is given in brackets: [].

OLREC (#97) [DCS]

INTRODUCTION

The OLREC project is an attempt to develop an On-Line pattern RECOgnition device. This device is to operate with only a "portable" amount of hardware and is to recognize patterns regardless of translation in any direction, rotation, or magnification. OLREC will not be backed-up by a large computer, but rather will consist of equipment which could, for example, be mounted in a robot. OLREC is to be able to recognize a pattern within approximately the same amount of time as that required by a human, that is, within approximately one second or less.

IMPLEMENTATION BEING CONSIDERED

Several different methods of implementing OLREC are being considered. In each of these methods, invariance to translation is implemented by physically moving the camera until the object is centered in the camera's field of view. This can be done using motors controlled by a current-balancing network. The invariance to magnification can be implemented by magnifying the image electronically or with a zoom lens until some point of the image touches the edge of the camera's field of view. This leaves the invariance to rotation and the actual recognition still to be implemented.

One possible implementation is to store in memory several different angular views of each pattern object. The acquisition of the different angular views for storage would probably be facilitated by the use of a radial scan camera as the input device. Once the different views of the pattern objects are stored, the test object can be compared to each view of each pattern object and the closest match determined.

Another method is to again use a radial scan camera for input and to store one view of each pattern object in memory. Since a radial scan camera is being used for input, however, other views of the objects can be obtained by merely addressing the memory from different starting locations. The test object can again be compared with several different views of each pattern object and the closest match determined.

The third method again uses a radial scan camera for input. This in effect, changes rotations into translations. Some sort of translation-independent transform can be taken of both the pattern images and the test image. The closest match could then be determined in the transform domain. The Fourier transform is one transform that exhibits translation independent properties. Consideration is being given to the possible use of other transforms and simpler methods for implementing the Fourier transform.

A fourth method consists of doing preprocessing and feature extraction to both the pattern images and the test image. A feature vector is then formed for each image. A clustering algorithm can be used to pick the closest match.

PROJECT STATUS

OLREC is a new project and at this point each of the above implementations is being investigated. Cost estimates and recognition times are being calculated for each implementation. Transforms that could be used for the third method are being considered as well as simpler methods of implementing the Fourier transform.

Randy Moss

1. Report No. UIUCDCS-R-78-917	2.	3. Recipient's Accession No.
4. Title and Subtitle Quarterly Technical Progress Report of the Information Engineering Laboratory		5. Report Date February 1978
6.		8. Performing Organization Rept. No. UIUCDCS-78-917
7. Author(s) Information Engineering Laboratory		10. Project/Task/Work Unit No.
9. Performing Organization Name and Address Department of Computer Science Information Engineering Laboratory University of Illinois Urbana, IL 61801		11. Contract/Grant No.
12. Sponsoring Organization Name and Address Dept. of Computer Science & School of Clinical Medicine University of Illinois Urbana, IL 61801		13. Type of Report & Period Covered Quarterly
14.		
15. Supplementary Notes		
16. Abstracts This report presents the abstracts for reports on recently completed projects, summary information on the status of current projects, and explanations of new projects at the Information Engineering Laboratory of the Department of Computer Science at the University of Illinois at Urbana-Champaign.		
17. Key Words and Document Analysis. 17a. Descriptors Technical Progress Report Computer Research Report		
18. Identifiers/Open-Ended Terms		
19. COSATI Field/Group		
20. Availability Statement		21. No. of Pages 17
22. Security Class (This Report) UNCLASSIFIED		23. Price
24. Security Class (This Page) UNCLASSIFIED		

JUN 20 1978



